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Studies on Midrapidity J/ψ Production as a Function of Charged-Particle Multiplicity with ALICE

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Introduction

- Recently, proton-proton (pp) and proton-lead (p-Pb) collision systems have attracted attention due to the observation in high-multiplicity events of apparent collective phenomena usually associated to lead-lead (Pb-Pb) collisions.
- The study of the J/ψ meson in correlation with the charged-particle multiplicity is a key point for the separation of the hard and soft scales, governing, respectively, the production and hadronization of the $c\bar{c}$ pair.
- Experimentally a stronger than linear increase of the charged-particle multiplicity with the J/ψ yield is observed.

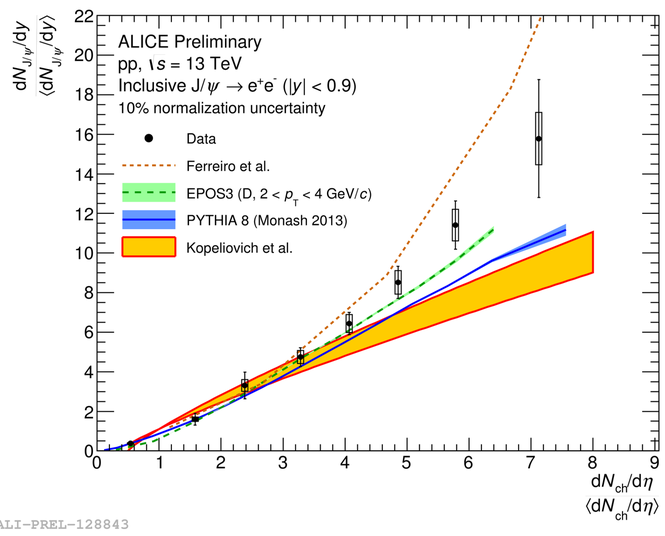


Fig. 1: Inclusive J/ψ yields as a function of the charged-particle multiplicity densities at midrapidity, compared to model predictions of PYTHIA8, EPOS3, the percolation model by Ferreiro et. al and the model by Kopeliovich et. al. Taken from [1].

Motivation

- To shed light on the causes for this behavior Monte Carlo simulations were performed with PYTHIA 8. The J/ψ production in correlation with the charged-particle multiplicity by different regions of the azimuthal angle with respect to the direction of the J/ψ meson, was investigated.
- The studies showed a stronger than linear increase of the J/ψ yield with the inclusive multiplicity while for the transverse region a weaker than linear increase was observed (Fig.2).

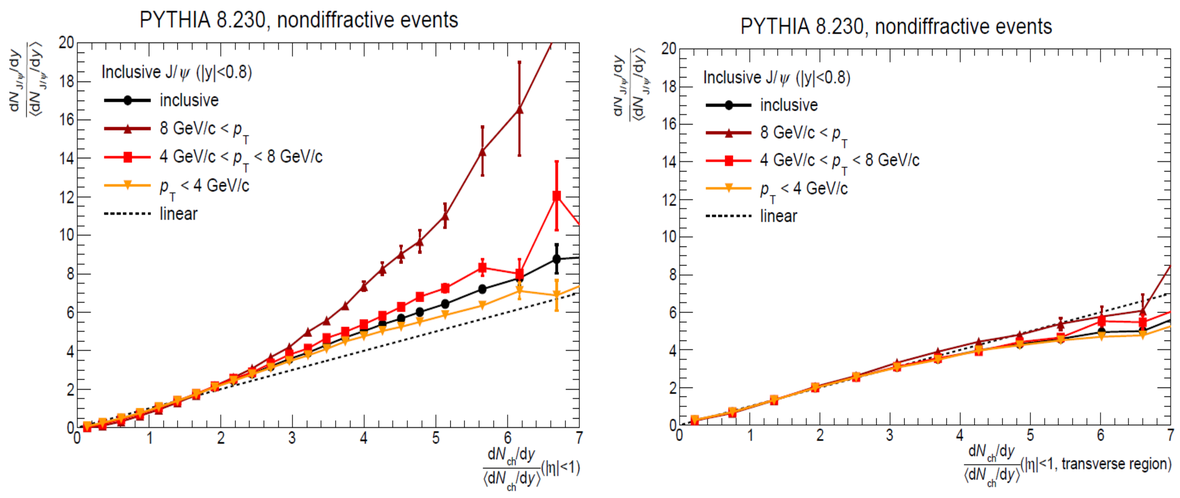


Fig. 2: Normalized midrapidity J/ψ production as a function of the normalized charged-particle multiplicity measured also at midrapidity in PYTHIA 8 simulations for different J/ψ p_T ranges. Left: Inclusive. Right: Transverse region respect to the J/ψ meson [2].

- The aim of this work is to study if the results obtained in pure PYTHIA 8 simulations could be confirmed considering the presence of background in the detection of the J/ψ meson signal.

Analysis description and results

- The J/ψ meson signal is detected from simulated events with PYTHIA 8.2 for the Run 2 period of data taking, on pp collisions at $\sqrt{s}$=13 TeV, (~15 million of events). The detection is performed via the di-electron channel at midrapidity ($|y|<0.9$). Full tracks are considered as estimators of the detected charged-particles.

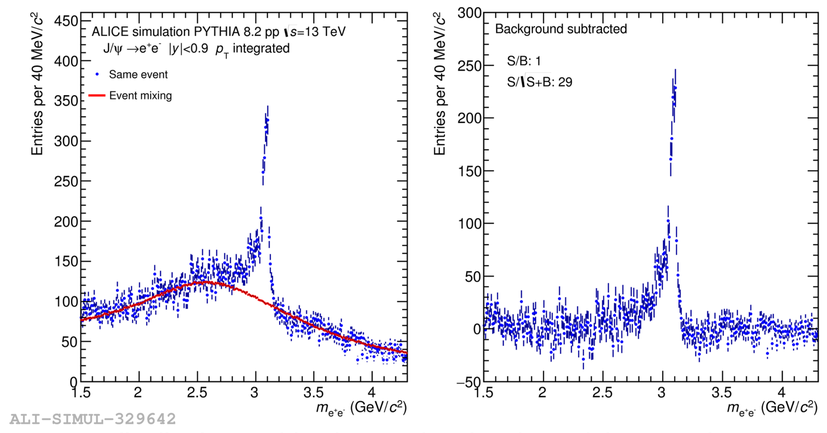


Fig. 3: Left: Invariant mass distribution and background estimation. Right: Invariant mass distribution after background subtraction (J/ψ signal).

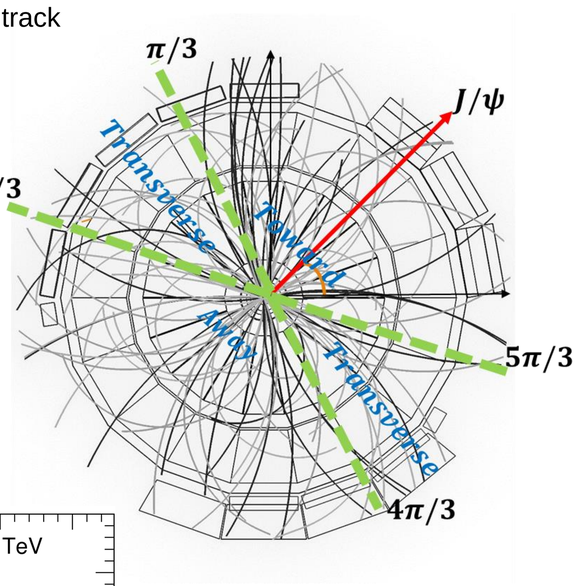
- Each region is defined with respect to the direction of the J/ψ di-electron pair candidate
- For each track one defines $\Delta\varphi = \varphi_{J/\psi} - \varphi_t$

  where: $\varphi_{J/\psi}$ is the azimuthal emission angle of the J/ψ pair candidate and φ_t is the azimuthal emission angle of the reconstructed charged-particle track

$\frac{5\pi}{3} < \Delta\varphi$ or $\Delta\varphi < \frac{\pi}{3}$ ⇒ Toward

$\frac{\pi}{3} < \Delta\varphi < \frac{2\pi}{3}$ or $\frac{4\pi}{3} < \Delta\varphi < \frac{5\pi}{3}$ ⇒ Transverse

$\frac{2\pi}{3} < \Delta\varphi < \frac{4\pi}{3}$ ⇒ Away



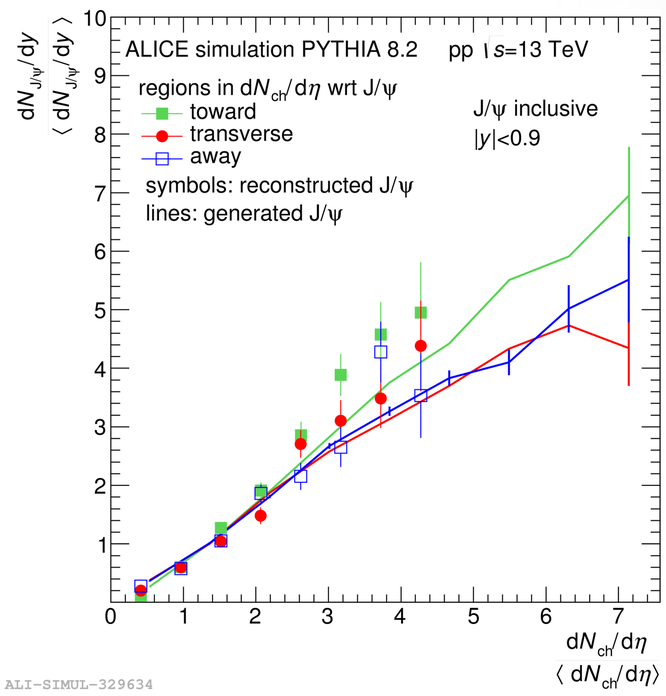


Fig. 4: Relative J/ψ yield at midrapidity as a function of the midrapidity normalized charged-particle multiplicity for each region defined regarding the azimuthal angle of the J/ψ meson.

Conclusions and Outlook

The obtained results with Monte Carlo PYTHIA 8 events on J/ψ production as function of the normalized charged-particle multiplicity in the three regions show that when the J/ψ meson signal is reconstructed as in data in the presence of background it is still possible to observe the weaker than linear behavior predicted for the transverse region in [2], even though the study is currently limited to the range of low multiplicity values. The analysis with ALICE experimental data is in progress.

References

[1] Weber, S.G (ALICE Collaboration), Nucl. Phys. A 967 (2017) 333, arXiv:1704.04735.
[2] Weber, S.G., Dubla, A., Andronic, A. et al. Eur. Phys. J. C 79 (2019) 36, arXiv: 1811.07744

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